

TITLE OF THE INVENTION**A METHOD OF MONITORING AND DISPLAYING HEALTH PERFORMANCE OF
AN AIRCRAFT ENGINE****BACKGROUND OF THE INVENTION****(a) Field of the Invention**

The present invention relates to the field of the health performance of an aircraft engine, and in particular, a method of determining and monitoring a set of output signals reflective of the engine health, for the creation of a new page on the multi-function display of the aircraft, and the representation of all engine health parameters in a qualitative form where visual effects are greatly enhanced.

(b) Brief Description of the Prior Art

Cockpit instrumentation display of an aircraft has always been one of the most important factors affecting pilot-machine interface. To minimise mental effort required by the pilot to interpret aircraft data, it is imperatively important for the pilot to pay attention to the contents and format of the data display.

The early conventional instruments of aircraft are generally analogue devices where engine performance of the aircraft cannot be presented visually to the pilot. The conventional instruments receive signals from the engine and display them on dial gauges. However, there is no analysis done on these signals. Even if there is a failure in any of the engine health parameters, no form of indication is provided to the pilot to warn him of danger. Therefore, there exists a need for a method to monitor the engine health parameters so as to provide the pilot a form of warning.

In modern aircraft, the concept of a "glass cockpit" has been widely adopted, where large areas of the cockpit of the aircraft are being taken up by large, multi-function displays, and thus, very limited space is left. The conventional, round, dial gauges that show the engine health had to be redesigned

to accommodate the new cockpit layout as the dial gauges take up too much space.

Another further drawback of the conventional analogue gauges of the aircraft is that the gauges are spread widely apart and require effort by the pilot in analysing the data as the displays are not intuitive. This is detrimental in modern air combat scenarios where high "g" forces are experienced.

In analogue dial gauges, there is little colour representation on the display. Colour representation aids greatly in situation awareness and visual effects, especially when the engine parameters are in dangerous region.

SUMMARY OF THE PRESENT INVENTION

In order to overcome the disadvantages of conventional method of presenting engine health parameters, the present invention provides a method of monitoring the engine health parameters leading to a creation of an enhanced engine performance indicator page.

It is an object of the present invention to provide a method of monitoring and displaying the actual health parameters of an aircraft engine, where all the engine health parameters will be displayed in a qualitative form (digital and graphical form) within a multi-function display on the aircraft.

A further object of the present invention is to provide a method of monitoring and displaying the actual health parameters of an aircraft engine, wherein the engine health parameters are sensed, recorded and output signals reflective of the current behaviour of the engine are generated.

It is yet another object of the present invention to provide a method of monitoring and displaying the actual health parameters of an aircraft engine, wherein the engine health parameters consist of rotation per minute (RPM), oil

pressure, fuel turbine inert temperature (FTIT), fuel flow indicator and nozzle position indicator (NPI).

Yet another object of the present invention is to provide a method of monitoring and displaying the actual health parameters of an aircraft engine, wherein all of the parameters are arranged in a straight scale and the parameters are grouped together, facilitating the pilot to analyse the data.

Yet a further object of the present invention is to provide a method of monitoring and displaying the actual health parameters of an aircraft engine, wherein the parameters of rotation per minute and fuel turbine inert temperature are displayed in a bar format while oil pressure and fuel flow are represented as fine lines.

A further object of the present invention is to provide a method of formation of an enhanced engine performance indicator, wherein the engine parameters, oil pressure and rotation per minute share the same scale, making efficient use of limited space of the multi-function display. Fuel flow and fuel turbine inert temperature are also measured using a single scale.

Yet another object of the present invention is to provide a method of formation of an enhanced engine performance indicator, where the nozzle position indicator is displayed in an intuitive way where one glance of the filled circle and the number displayed will allow the pilot to determine the present nozzle position, without much effort.

Another object of the present invention is to provide a method of formation of an enhanced engine performance indicator, wherein the normal healthy colour is blue for rotation per minute and fuel turbine inert temperature, and if any of these indicators detect engine failures, the respective bar display will turn red, and the number displayed above the bar will turn red and blink, facilitating the pilot to tell

immediately any failures found by looking at the colours on the display.

Yet another object of the present invention is to provide a method of formation of an enhanced engine performance indicator, wherein the fine lines beside the bar displays represent the healthy and failure regions for rotation per minute and fuel turbine inert temperature, facilitating the pilot to tell immediately which parameters are in the failure region.

Other objects as well as the numerous advantages of the method in accordance with the present invention will become apparent from the following detailed description and the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

Fig. 1 is a schematic view showing an enhanced engine performance indicator of the present invention, displayed on a multi-function display, showing the layout and contents of the engine performance indicators.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

The schematic drawing of Fig. 1 provides an overview of the enhanced engine performance indicator page in accordance with the present invention.

The conventional analogue dial gauges that show the engine health are redesigned to be displayed in a qualitative way and displayed as a new page on the multi-function display. In accordance with the present invention, it is called the enhanced engine performance indicator page and shown in Figure 1.

In accordance with the present, a method of monitoring and displaying the actual health parameters of an aircraft engine under normal operating conditions comprises the steps of

- (a) sensing the engine performance related parameters at operable positions of the aircraft engine;
- (b) recording and generating continuous output signals reflective of the current behaviour of the engine;
- (c) comparing the output signals with a set of predetermined reference signals to determine if any failure conditions exist for each individual parameter;
- (d) providing an indication of the failed engine parameter; and
- (e) simultaneously displaying all the representative values of the health parameters in a digital and graphical form.

In accordance with the present invention, the engine health parameters are determined using a plurality of sensors placed at operable positions of the engine.

The parameters are recorded and continuous output signals reflecting the current behaviour of the engine are generated. These output signals are compared with predetermined reference signals in order to determine if any failure conditions exist for each individual parameter. If a failure is detected, an indication is provided to the pilot to warn him of danger. In accordance with the present invention, the signals are outputted to a multi-function display on the aircraft where all the health parameters are displayed simultaneously in a digital and graphical form. Such form of display has greatly enhanced the situation awareness of the pilot.

As shown in Figure 1, the parameters displayed include rotation per min (RPM), oil pressure, fuel turbine inert temperature (FTIT), fuel flow and nozzle position indicator (NPI).

Rotation per minute and fuel turbine inert temperature are displayed in a bar format. The absolute values will be displayed above the respective bars. The bar display will be blue if the parameters are operating in the healthy region. The bar display will turn red, and the number displayed above the bar will be red and starts to blink when the indicator detects a failure. The healthy (blue) and failure (red) regions for rotation per minute and fuel turbine inert temperature are defined by the

thin, coloured lines found besides the respective bar displays.

Rotation per minute is expressed in percentage from zero to one hundred. It will indicate failure with the value decreases below forty-nine percent or is greater than one hundred percent. Similarly, fuel turbine inert temperature is expressed in degrees Celsius, from two hundred to one thousand four hundred. It will indicate failure when the value exceeds one thousand one hundred degrees.

Oil pressure is expressed in PSI, from zero to one hundred and shares the same scale as rotation per minute. It is represented by a thin, yellow line (PSI). The absolute value is displayed below the rotation per minute bar and is also yellow to correspond to the line.

The fuel flow indicator displays the total fuel flow to the engine in pounds per minute. The range is from zero to one thousand four hundred. It is represented by a thin, green line (ppm) and shares the same scale as fuel turbine inert temperature. The absolute value is displayed below the fuel turbine temperature bar and is also green in to correspond to the line.

The nozzle position indicator (NPI) displays the position of the exhaust nozzle, which is calibrated from zero to one hundred percent. The size of the filled circle and the number displayed inside represents the present nozzle position. A fully filled circle with one hundred percent displayed shows that the nozzle is fully open while zero percent represents a fully closed nozzle.

In accordance with the present invention, the engine parameters, rotation per minute and oil pressure share the same scale while the fuel turbine inert temperature and fuel flow share the same scale. In addition, rotation per minute is shown as a bar display while oil pressure is displayed as a fine line. Similarly, fuel turbine inert temperature is shown as a bar display while fuel flow is displayed as a fine line. The healthy and failure regions for the engine parameters, rotation per

minute and fuel turbine inert temperature are displayed as fine lines beside the respective bar displays.

It will be appreciated that the foregoing is considered as illustrative only of the principles of the invention and numerous modification and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact method described, and accordingly, all suitable modification and equivalents may be resorted to, falling within the scope of the invention.

CLAIMS

1. A method of monitoring and displaying the health parameters of an aircraft engine under normal operating conditions, comprising the steps of
 - (a) sensing engine parameters at operable positions of the aircraft engine;
 - (b) recording and generating continuous output signals reflective of the current behaviour of the aircraft engine;
 - (c) comparing said output signals with a set of predetermined reference signals to determine the existence of failed engine parameters;
 - (d) providing an indication of the failed engine parameters; and
 - (e) simultaneously displaying all representative values of the health parameters in a digital and graphical form.
2. A method of monitoring and displaying the health parameters of an aircraft engine under normal operating conditions as set forth in Claim 1, wherein the health parameters include rotation per minute, fuel turbine inert temperature, fuel flow, oil pressure and nozzle position indicator.
3. A method of monitoring and displaying the health parameters of an aircraft engine under normal operating conditions as set forth in Claim 1 or 2, wherein said health parameters displayed in a qualitative form enhance situation awareness.
4. A method of monitoring and displaying the health parameters of an aircraft engine under normal operating conditions as set forth in Claim 1 or 2, wherein, rotation per minute and oil pressure share the same scale, and the fuel turbine inert temperature and fuel flow share the same scale.
5. A method of monitoring and displaying the health parameter of an aircraft engine under normal operating conditions as set forth in Claim 2, wherein the rotation per minute and fuel turbine inert temperature are shown as bar



displays while oil pressure and fuel flow are represented by fine lines.

6. A method of monitoring and displaying the health parameter of an aircraft engine under normal operating conditions as set forth in Claim 1 or 2, wherein the health parameters form an enhanced engine performance indicator page on a multi-function display of the aircraft.
7. A method of monitoring and displaying the health parameter of an aircraft engine under normal operating conditions as set forth in Claim 1, wherein the respective bar display for the rotation per minute or fuel turbine inert temperature turns red, and the number displayed above the bar turns red and blink upon a detection of failure in the engine parameters.
8. A method of monitoring and displaying the health parameter of an aircraft engine under normal operating conditions as set forth in Claim 1, wherein the healthy and failure regions for the engine parameters, rotation per minute and fuel turbine inert temperature are displayed as fine lines beside the respective bar displays.
9. A method of monitoring and displaying the health parameter of an aircraft engine under normal operating conditions as set forth in Claim 1, a nozzle position indicator is displayed as concentric circles.
10. A method of monitoring and displaying the health parameter of an aircraft engine under normal operating conditions as set forth in Claim 9, wherein the size of the circle and the number displayed represent the present nozzle position.

